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AIR FORCE SCIENTIST AND ENGINEER ROLES IN COMBATING WEAPONS OF MASS DESTRUCTION

by

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Contents

Page

Preface

I would like to thank my wife, Cindy, and daughters, Christy and Jessica, for their patience and understanding while I cluttered our home with reference material during the writing of this paper. I would also like to thank my advisor, Dr. Charles Costanzo, for his support and interest in this topic. I extend my gratitude to Major General Robert Smolen (AF/XON), Dr. Billy Mullins (AF/AXON), and Lt Col Donald Robbins (AFNWCA/CC) for their support of the Air Force chemical, biological, radiological, and nuclear scientist and engineer community. Finally, I would like to thank all of the Air Force's unsung heroes--our chemical, biological, radiological, and nuclear scientists and engineers—for their contributions in protecting our country from the gravest threat it has ever faced. I am privileged to be included among their ranks. It is my profound hope that this document becomes the first among many to lay the foundation for organizing our great scientists and engineers to protect our country from the ominous threat of weapons of mass destruction.

Abstract

The threat of weapons of mass destruction (WMD) is a real threat to the United States homeland, our deployed forces, and our allies. Science and technology (S&T) will play a key role in helping defeat this threat. This paper discusses the current and potential roles of Air Force chemical, biological, radiological, and nuclear (CBRN) scientists and engineers (S&Es) in combating WMD. Specifically, it will analyze key strategic documents for linkages requiring CBRN S&Es. Further, the paper reviews current Joint and Air Force doctrine for the capabilities of this group and briefly discusses where the Air Force employs these personnel. Following this review, I address developmental education requirements for CBRN S&Es and discuss how current Air Force initiatives for force development provide a unique opportunity for transformation of this group to better combat WMD while meeting the objectives of DOD transformation. The paper makes two key recommendations. First, the Air Force should develop doctrine specific to science and technology (S&T), linking it to our operations to better integrate of our myriad capabilities. Secondly, the Air Force should consider restructuring its officer S&E career fields to allow for a "technical-operations" specialist focused on providing transformational capabilities to the warfighter.

Chapter 1

Introduction

We must accord the highest priority to the protection of the United States, our forces, and our friends and allies from the existing and growing WMD threat.

—National Strategy to Combat Weapons of Mass Destruction, December 2002

The threat of weapons of mass destruction (WMD) use against the United States, its forces, and allies and friends is perhaps greater today than it was during the height of the Cold War. During the Cold War, this threat was characterized by the potential massive use of nuclear, chemical, and biological weapons by a single state—the Soviet Union. Today, the threat of WMD includes chemical, biological, radiological, and nuclear, and high-yield explosives (CBRNE) weaponry employed by state or non-state actors against deployed US forces, our allies, and the US homeland. To protect the United States and our allies, the Department of Defense (DOD) and the United States Air Force must develop and resource a strategy to combat this threat. Air Force scientists and engineers will play a critical role in countering the WMD threat.[1] Finally, it bears noting that several high-level reports have concluded that the DOD and Air Force lack sufficient expertise at this time to deal with the CBRN threat.[2] This paper seeks to identify requirements and a path forward to deal with this problem.

Purpose

Historically, the United States Air Force developed and retained a cadre of scientists and engineers (S&Es) to support our nuclear deterrence and counterproliferation missions.[3] The purpose of this paper is to discuss the scope and need for continuation and enhancement of these capabilities in the post-Cold War/post-9-11 environments in light of national, DOD, and Air Force requirements. Specifically, I will discuss how specific doctrine and strategic direction require a cadre of specialized S&Es; the current organizations which employ them; and the unique education, training, leadership development, personnel requirements for this group. Although the threat of high-yield explosives is greater than CBRN weaponry, this paper will focus on the roles of S&Es to combat chemical, biological, radiological, and nuclear weapons.[4]

The rest of this section defines the unique attributes of "CBRN S&Es" and the military challenge of the CBRN threat. Chapter two presents current doctrine and strategic direction necessitating the need for CBRN expertise in the S&E corps and briefly discusses where CBRN S&E personnel current perform their missions. In chapter three, I discuss the institutional aspects of maintaining and growing the CBRNE S&E workforce: education and training, leadership development, and personnel policies. Finally, chapter four concludes with a summary of the paper and recommendations.

The CBRN S&E Defined

The term "CBRN S&E" is used throughout this paper to describe a scientist or engineer with expertise and experience directly relevant to the technical development, detection, protection against, or effects assessment of chemical, biological, radiological, and nuclear weapons or weapons that produce similar effects (such as electromagnetic pulse—EMP—generators). The key aspects defining such an individual are education coupled with experience (expertise). The

author posits that the technical details of CBRN weapons and their effects necessitates a focused expert to effectively, consistently, and economically address the unique operational, scientific, and technological issues associated with them. Further, I acknowledge there is little science or engineering which naturally bonds CBRN experts together (i.e., the science and effects of chemical and biological weapons are substantially different from those of radiological and nuclear weapons.) However, the "CBRN S&E" construct is useful in bonding these groups for mission-focused functional management (counter-CBRN), as is currently employed by the Air Force.[5]

The Military Challenge of CBRN

The DOD and Air Force have recently shifted their focus from a threat-based to a capabilities-based planning environment.[6] Thus, rather than focusing on specific threats, we are now assessing the capabilities of our enemies and potential enemies to deny the US freedom of action by preventing US access to ports and airfields, as well as threatening potential allies and the US homeland. WMD provide our enemies a means to asymmetrically attack the US and our forces while avoiding direct confrontation with our substantial conventional military capabilities. The prospect of rapid CBRN weapon proliferation further exacerbates the difficulty involved in assessing this threat. The following sections discuss the unique military and technical challenges of CBRN weapons.

Chemical Weapons[7]

Chemical weapons have been used militarily as far back in recorded history as 423 B.C. during the Peloponnesian War, with many examples since.[8] However, it was not until the advent of modern chemistry that the lethality of chemical weapons was able to reach a level of

destruction placing it in the category of WMD. The military challenges of chemical weapons are myriad. First, chemical weapons come in many forms with different effects. Some agents are deadly in microscopic quantities, whereas others require relatively large doses to produce an effect. Further, the basic chemistry of chemical weapons allows a variation of the persistency of the agent ranging from hours to days. The quantity, persistency, and variety of chemical agents necessitate very strong prophylactic measures[9] (i.e., mission-oriented protective equipment—MOPP gear) and sensitive detection equipment to support force protection of exposed personnel and equipment. From an intelligence perspective, the development of chemical agents is difficult to determine due to the dual-use nature of the production processes involved. Lastly, in addition to traditional chemical agents, many pollutants and toxic chemicals can be employed against military forces and are potentially very attractive for use against unprotected (civilian) personnel.

The above military challenges provide unique difficulties to the technologist. The large variety of agents and their environmental persistency require very sensitive and accurate detection equipment that must be employed in battlefield conditions. Development of protective equipment provides challenges due to the caustic and intrusive nature of many agents and the need to provide a balance between protective utility and operational utility: personnel in MOPP gear must be able to accomplish their missions while so garbed. Further, military hardware must be designed to survive not only the chemical agent but also any decontamination measures applied, many of which are also damaging. Finally, the detection and timely characterization of proliferant and clandestine chemical weapons programs requires extremely advanced sensors and personnel able to discriminate between dual-use and chemical weapon specific processes.[10]

Biological Weapons[11]

Similar to chemical weapons, biological weapons have been part of warfare since antiquity.[12] Recent examples include the admission of the Iraqi leaders in 1995 that they had stockpiled biological weapons and admissions by Dr. Ken Alibek of an illegal Russian biological warfare program (Biopreparat) in existence following the signing of the 1972 Biological Weapons Convention. This program resulted in accidental releases of both smallpox (Aralsk, Kazakhstan in 1971) and anthrax (Sverdlovsk, Russia in 1979), killing numerous Russia citizens.[13]

The military challenges of biological weapons are similar to chemical weapons. Biological weapons come in many forms and possess both lethal to non-lethal effects. Additionally, they also vary in their persistency following release. However, biological weapons are generally able to produce an effect in very small quantities and are difficult to detect until mass contagion occurs. Further, many agents are spread by person-to-person contact, often resulting in an exponential growth pattern if not contained.

The technical challenges resulting from biological weapons are enormous. The potentially exponential effect of contagion requires extremely fast and accurate detection techniques, generally nonexistent today. Because biological agents can linger in the environment in lethal quantities, protective gear and decontamination measures are important weapon system development aspects. Finally, long-range detection and characterization of proliferant biological weapons programs is difficult and requires significant expertise and advanced sensors to support.[14]

Radiological Weapons[15]

The purpose of a radiological weapon is to deny an area to an enemy by emplacing dangerous quantities of radioactive substances on the target. Radiological weapons also have the capability to produce a psychological effect in civilian populations far in excess of their physically damaging effects. Following the first Gulf War, it was found that Iraq had explored to the possible development of radiological weapons.[16] Further, terrorists are exploring use of radiological weapons, as evidenced by the Jose Padilla case (the alleged Al Qaeda dirty bomber).[17] Similar to the radioactive fallout following a nuclear detonation or major nuclear accident, radiological weapons materials are characterized by extremely penetrating high radiation levels. Such high radiation levels can produce casualties to unsuspecting victims in the form of radiation sickness.

Science and technology (S&T) is critical to countering radiological weapons. Because these weapons potentially emanate large amounts of radiation, development of advanced detectors will provide a potential first line of defense at key locations. The problem is compounded by the need for specialized equipment to detect radioactive materials, because nuclear radiation generally cannot be sensed except by technical methods. Further, development of advanced models and simulation methods supports consequence management of a radiological attack.

Nuclear Weapons

Nuclear weapons are the most destructive of CBRN weapons. Fortunately, they are possessed by few states at this time: United States, Russia, China, United Kingdom, France, India, and Pakistan. Further, it is suspected that North Korea and Iran have active nuclear weapons programs.

Nuclear weapons produce their effects by releasing huge quantities of energy (generally greater than 1000 tons of TNT, or 1 kiloton, equivalent), which results in a large blast, thermal radiation, initial radiation (gamma rays and neutrons), and long-lived radioactive fallout. Additionally, nuclear weapons produce an EMP that can disable or destroy unprotected electronics. Finally, whereas chemical, biological, and radiological weapons have little effect on space systems, an exo-atmospheric nuclear detonation can produce crippling amounts of electron radiation and x-rays that can destroy unprotected satellites and their communication links.[18] Nuclear weapons can destroy both massed forces (through blast and heat) and dispersed forces (through EMP and fallout). Thus, specially designed hardware is required to protect military systems from their effects.

Historically, the Air Force and DOD have focused substantial amounts of S&T to solve the problems posed by nuclear weapons. This effort ranged from development, testing, and sustainment of nuclear weapons to protecting (hardening) systems against their effects. Technical monitoring of nuclear treaties requires a wide-range of expertise ranging from seismologists and geologists to nuclear engineers and chemists.

Notes

[1] Indeed, *The National Security Strategy to Combat Weapons of Mass Destruction* devotes an entire paragraph entitled "Research and Development," page 6.

[2] In 2004, the National Research Council and National Academy of Sciences concluded that the DOD did not have sufficient expertise to adequately address the biological weapons threat (Loeb, Vernon "Biodefense Agency Urged for Safety of US Troops," Washington Post, 23 Jan 04, p. 19). The Defense Science Board identified lack of WMD expertise in supporting the DOD C-CBRN role in Homeland Defense (OSD(AT&L), *Defense Science Board 2003 Summer Study on DOD Roles and Missions in Homeland Security Volume 1*, Washington, D.C., November 2003, executive summary). Finally, the President's 2002 Nuclear Posture Review identifies infrastructure as a key of element of the "new triad," requiring nuclear expertise to support.

[3] The Air Force Weapons Laboratory (AFWL) was traditionally the Air Force's bastion of WMD scientists and engineers. Realignment of the AFWL under the Air Force Research Laboratory in the mid-1990s and the end of the Cold War substantially reduced the Air Force's force structure requirements for such scientists and engineers.

Notes

[4] In addition to chemical, biological, radiological, and nuclear weapons, the DOD is also concerned with the threat of high-yield explosives. The inclusion of this threat creates an acronym known as CBRNE—chemical, biological, radiological, nuclear, and high-yield explosives.

[5] The S&E Functional Manager is SAF/AQR. AF/XON is responsible for providing functional management for CBRN S&E personnel in support of SAF/AQR.

[6] Jumper, John General *Capabilities Review and Risk Assessment*, available at http://www.af.mil/media/viewpoints/sight_11feb02.pdf.

[7] Chandler, Robert W. *The New Face of War*. McLean, VA: AMCODA Press, 1998, p.81-102.

[8] Ibid. p.81.

[9] Schneider, Barry R. *Combat Effectiveness in MOPP 4: Lessons from the US Army CANE Exercises*, In *The War Next Time: Countering Rogue States and Terrorists Armed with Chemical and Biological Weapons*, Edited by Dr. Barry Schneider et al. USAF Counterproliferation Center, Maxwell AFB AL, 173-183, 2003.

[10] *Integrated Chemical and Biological Research, Development, and Acquisition Plan: Chemical & Biological Point Detection, Decontamination. Information Systems,* April 2003, available at http://www.acq.osd.mil/cp/rdaplancbpointdecon_apr03.pdf.

[11] Chandler, Robert W. *The New Face of War*. McLean, VA: AMCODA Press, 1998, p.57-79.

[12] Ibid, Chapter 3.

[13] DuBois, Dorothy L. *Pointing the Finger: Unclassified Methods to Identify Covert Biological Warfare Programs*, In *The War Next Time: Countering Rogue States and Terrorists Armed with Chemical and Biological Weapons*, Edited by Dr. Barry Schneider et al. USAF Counterproliferation Center, Maxwell AFB AL, November 2003, 89-144.

[14] *Integrated Chemical and Biological Research, Development, and Acquisition Plan: Chemical & Biological Point Detection, Decontamination. Information Systems,* April 2003, available at http://www.acq.osd.mil/cp/rdaplancbpointdecon_apr03.pdf.

[15] Chandler, Robert W. *The New Face of War*. McLean, VA: AMCODA Press, 1998, p.51-53, 1998.

[16] Ibid. p.51-53.

[17] Wagner, Alex "US Announces it Uncovered 'Dirty Bomb' Plot," The Arms Control Association, July/August 2002, http://www.armscontrol.org/act/2002_07-08/dirtybombjul_aug02.asp.

[18] The importance of protecting critical satellite systems has been highlighted recently by the Honorable Peter Teets, Undersecretary of the Air Force. Chun provides a plausible scenario for reemergence of nuclear ASAT capabilities among the developing nuclear powers (Chun, Clayton K.S. *Shooting Down a "Star": Program 437, the US Nuclear ASAT System and Present-Day Copycat Killers*, CADRE Paper No. 6, College of Aerospace Doctrine Research and Development (CADRE), Air University Press, Maxwell AFB AL, 1999). Giffen's treatment is a classic analysis of the threat to space systems, with emphasis on mitigation strategies (Giffen, Robert B. *US Space System Survivability: Strategic Alternatives for the 1990s*, National Security Affairs Monograph Series 82-4, National Defense University Press, Washington DC, 1982).

Chapter 2

Doctrine and Requirements Requiring the CBRN S&E

The United States has a critical need for cutting-edge technology that can quickly and effectively detect, analyze, facilitate interdiction of, defend against, defeat, and mitigate the consequences of WMD.

— National Strategy to Combat Weapons of Mass Destruction, December 2002

As evidenced by the President's *National Strategy to Combat Weapons of Mass Destruction*, S&T (and thus S&Es) figure prominently in the national response to countering WMD. This section will analyze unclassified strategic direction and operational doctrine with respect to countering CBRN threats and discuss their relevance to Air Force S&Es. From a strategic perspective, I will review the *National Strategy to Combat Weapons of Mass Destruction;* the Office of the Secretary of Defense's *Military Transformation: A Strategic Approach*, and the *Strategic Deterrence Joint Operating Concept.* At the operational level, I will analyze *The US Air Force Transformation Flight Plan* and relevant Joint and Air Force doctrine. Specifically, we will look at *Joint Publication 3-11*; *Air Force Doctrine Document 2-1.8*, and the *Concept of Operations for Scientists and Engineers in the United States Air Force*.

Strategic Direction

The National Strategy to Combat Weapons of Mass Destruction[1]

The current administration has produced several functionally-oriented national strategies dealing with combating terrorism, homeland security, and weapons of mass destruction. The purpose of these documents is to focus disparate national capabilities, such as the defense establishment, homeland security, and the intelligence community on key objectives.

The central message of the *National Strategy to Combat Weapons of Mass Destruction* is the presentation of the pillars of our national strategy: counterproliferation to combat WMD use, strengthened nonproliferation to combat WMD proliferation, and consequence management to respond to WMD use. The counterproliferation pillar encompasses interdiction of WMD, deterrence of WMD use, and defense and mitigation of WMD effects. Nonproliferation involves active diplomacy, mulitilateral control regimes, cooperative threat reduction, and material/export controls. Consequence management ensures that we are prepared for potential WMD use against the US or our allies. The strategy recognizes explicitly that intelligence collection and analysis and research and development are key to integrating the pillars.

Our national strategy requires S&Es across a broad range of organization s coordinate their activities for an effective response. CBRN S&Es in the DOD, Office of Homeland Security, Intelligence Community, and Department of Energy (DOE) must continue to develop a community of knowledge so that S&T solutions to combat WMD can be quickly provided to those who need them. Further, some solutions may actually require an S&E to provide the operational expertise in order to be successfully employed.

Military Transformation: A Strategic Approach[2]

Military transformation is a clear goal of both the president and the Secretary of Defense. The purpose of *Military Transformation: A Strategic Approach* is to present the strategy of the DOD in transforming our military capabilities consistent with the US defense strategy of assuring our allies, dissuading future military competition, deterring threats and coercion against US interests, and decisively defeating any adversary should deterrence fail.[3] The goal of transformation is to change how we do business in areas such as requirements and technology development and personnel policies, transform how we work with others to fully realize the strength and synergy of the interagency environment, and transform how we fight by developing new concepts of operation and fully realizing the synergy of joint warfighting. The operational goals of transformation are protecting critical bases, projecting and sustaining forces, denying enemy sanctuary, leveraging information technology, assuring information systems, and enhancing space capabilities.

CBRN S&Es play critical roles across the spectrum of transformation. Among the six operational goals, CBRN expertise is clearly required. S&Es support the protection of our bases and the homeland by developing and fielding systems that detect CBRN weapons, protect equipment and personnel from their effects, and mitigate these effects. S&Es are critical to denying the enemy sanctuary by developing and operating advanced intelligence, surveillance, and reconnaissance systems to detect CBRN weapons. Further, CBRN S&Es develop advanced conventional and nuclear weapons to negate adversary WMD located in hardened and deeply buried structures, while limiting collateral damage. Finally, our S&Es provide critical knowledge and skills to protect our information and space systems from the effects of CBRN weapons.

Strategic Deterrence Joint Operating Concept[4]

Joint Operations Concepts (JOpsC) "provide strategic guidance that identifies future capabilities required to achieve the Chairman of Joint Chiefs of Staff's vision of achieving Full Spectrum Dominance by the Joint Force." The *Strategic Deterrence Joint Operating Concept* describes how the joint force will contribute to strategic deterrence strategy through 2015. Defined as prevention of adversary aggression or coercion threatening vital interests of the United States, strategic deterrence seeks to convince adversaries not to take potentially grievous courses of action.

The "means" available to the Joint Force Commander to support strategic deterrence include global situation awareness, command and control, overseas presence, allied/coalition military cooperation, force projection, nuclear strike capabilities, active and passive defenses, global strike, information operations, inducement operations, and space control. The JOpsC assumes that CBRN proliferation will continue at an accelerated rate over the next decade and that the US could become involved in one or conflicts with nuclear armed countries in this period. Additionally, adversaries will develop advanced weapons technology (e.g., directed-energy weapons and EMP weapons) placing US technological prowess at risk.

CBRN S&Es will provide many components of the necessary military capabilities to support the JOpsC. Supporting global situation awareness, CBRN S&Es develop and operate advanced detection capabilities, protect our information and intelligence systems, and support the attribution of CBRN weapon use to the perpetrator. S&Es support the development and protection of robust command and control systems capable of operating under the most severe of circumstances (such as trans-nuclear attack). CBRN S&Es provide the warfighter modeling and simulation tools to assess the effects of adversary WMD attack and assess the collateral effects of US attacks on CBRN targets. Critical to our nuclear strike capabilities, CBRN S&Es provide

the expertise to develop advanced nuclear weapons and assure the efficacy of the US nuclear stockpile. Active and passive defenses against the effects of CBRN and advanced conventional weapons (such as EMP weapons) will be provided by CBRN S&Es. Global strike capabilities will likely be employed either overtly or covertly against adversary WMD—CBRN S&Es will play a critical part in bringing the right capabilities to the warfighter in this context. CBRN S&Es have a potentially central role in inducement operations by providing the expertise to help the Joint Force Commander secure, dismantle, and eliminate WMD infrastructure. Finally, space control will require CBRN S&Es to protect our space and ground segment from the effects of CBRN use—particularly nuclear weapons.

Operational Level Doctrine

Evolving in some cases from strategic direction, operational doctrine provides the conduit from strategic direction to tactical procedures. Analysis of Joint and Air Force doctrine provides the *raison d'être* for Air Force CBRN S&Es—providing capabilities for operations. This section will briefly analyze *The US Air Force Transformation Flight Plan; Joint Publication 3-11: Joint Doctrine for Operations in Nuclear, Biological, and Chemical (NBC) Environment; Air Force Doctrine Document 2-1.8: Air Force Nuclear, Biological, and Chemical Operations; and the Concept of Operations for Scientists and Engineers in the United States Air Force.*

The United States Air Force Transformation Flight Plan[5]

The Air Force Transformation Flight Plan details how the Air Force is transforming to meet anticipated threats and opportunities. Air Force transformation seeks to move the Air Force and its processes from an "industrial age" focus to the "information age." Further, the transition from a Cold War force to the post-Cold War force requires changes in how the Air Force

structures itself to meet these challenges. Specifically, the USAF is preparing to meet the challenges of terrorism, weapons of mass destruction, and threats to our space systems. Its strategy for transformation is to enhance joint warfighting, aggressively pursue innovation, create agile and flexible organizations, shift from a threat-based/platform-centric planning and programming paradigm to a capabilities-based/effects-based approach, develop transformational capabilities, and break out of industrial age business processes.[6] The Air Force will execute this strategy in concert with our core competencies:[7] developing airmen, integrating operations, and technology-to-warfighting—the key core competency requiring an organic USAF S&E workforce.

The "flight plan" commits the USAF to supporting the Joint Force Commander by providing a capability to provide for predictive battlespace awareness against CBRN weapons, strike targets anywhere on the globe (including CBRN targets), protect space systems, protect critical infrastructure, and assure continuous operations in the CBRN environment. These capabilities require the Air Force to maintain a cadre of CBRN-savvy S&Es in order to ensure Air Force capabilities can provide the needed joint warfighting capabilities against any CBRN-armed opponent and sustain our own nuclear/advanced weapon capabilities.

Joint Doctrine for Operations in Nuclear, Biological, and Chemical (NBC) Environments[8]

The *Joint Doctrine for Operations in Nuclear, Biological, and Chemical (NBC) Environments (JP 3-11)* provides the joint framework for operations in the WMD environment. It predates the events of 9-11. However, many of its tenets clearly require S&T in order to facilitate military operations in the CBRN environment.

The central tenets of JP 3-11 are peacetime preparedness (including homeland security), sustaining combat operations in the CBRN environment, health service support, supporting

conflict termination in the CBRN environment, and military operations other than war. CBRN S&Es are implicitly required to support the Joint Force Commander (JFC) across many areas. Peacetime preparedness requires CBRN S&Es to provide protective and detection equipment, including training for advanced capabilities. Further, they provide him or her with analytical capabilities to support intelligence preparation of the battlefield operations. Finally, as experts on the effects of CBRN weapons, they provide the JFC with technical knowledge of the effects of counterforce attacks against enemy CBRN supporting both operational assessments, targeting, weaponeering, and battle damage assessments.[9]

During sustained combat operations, whether deployed or providing reach-back support, CBRN S&E personnel are capable of providing advanced capabilities to detect and quantify CBRN weapon effects by supporting ISR operations, augmenting readiness personnel in assessing CBRN effects for the JFC, and complimenting medical personnel by providing CBRN expertise and risk assessments. If deployed, S&Es can operate advanced nuclear, chemical, and biological weapons detection capabilities thereby supporting force protection for the JFC. Further, they are able to provide deployed laboratory services to isolate particular agents and pathogens in order to facilitate rapid identification to counter adversary CBRN use.

During conflict termination and military operations other than war, CBRN S&E personnel provide unique expertise to the JFC by supporting mitigation of residual hazards and decontamination approaches. They also provide expertise to special search, identification, control, and recovery teams tasked with eliminating adversary CBRN capabilities. Such teams require a myriad of S&E capabilities ranging from knowledge of CBRN production processes, forensic analysis of CBRN materials, operation of sensitive detection equipment, and knowledge

of CBRN ordnance disposal. CBRN S&Es may also provide support to special operations forces in support of covert counterproliferation operations.

Counter Nuclear, Biological, and Chemical Operations[10]

Air Force WMD doctrine supports and compliments joint doctrine. Thus, the Air Force brings unique capabilities to the joint and interagency arena for combating WMD. The Air Force's approach to countering nuclear, chemical, and biological weapons is a balanced approach with four pillars: proliferation prevention, counterforce, active defense, and passive defense. Underwriting these pillars are command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) and counter-NBC terrorism capabilities.

CBRN S&Es support proliferation prevention by providing inspection, verification, and enforcement of nonproliferation treaties, control protocols, and export control activities. With respect to counterforce operations, CBRN S&Es help to identify potential proliferants (ISR function) and support the warfighter by providing input to planning of counter-CBRN operations—particularly with respect to limiting collateral damage against CBRN targets. Additionally, S&Es provide a solid interagency conduit to organizations such as the Defense Threat Reduction Agency (DTRA) and the Department of Energy's National Nuclear Security Administration (NNSA), the Defense Intelligence Agency, and Central Intelligence Agency with regard to CBRN weapon effects assessments, nuclear weapons employment, and WMD proliferation. Finally, supporting passive defense operations, CBRN S&Es provide technical knowledge to the warfighter supporting contamination avoidance, protection, and contamination control. Although passive defense operations are generally carried out by the Air Force's civil engineering readiness and Biomedical Services Corps personnel, CBRN S&Es have a key role to play in providing advanced protective equipment; developing, operating, and evaluating the

output of advanced consequence management software; and operating advanced CBRN detection equipment in support of contamination avoidance and control operations.

Concept of Operations for Scientists and Engineers in the United States Air Force[11]

The *Concept of Operations for Scientists and Engineers in the United States Air Force* provides a vision for how the Air Force will continue to develop and sustain technological dominance. Although it does not explicitly discuss CBRN S&Es and their contribution, the CONOPS provides the template for what AF CBRN S&Es do to support the joint warfighter.

Consistent with the *Transformational Flight Plan* and the Air Force core competency of technology-to-warfighting, Air Force S&Es provide a qualitative technological advantage to the warfighter through innovation and by fusing technology and operations. Additionally, S&Es help to sustain our weapons systems, many of which are well past their system design life—including our nuclear weapons and their delivery systems. To provide technological dominance, S&Es provide knowledge and technology generation and analysis; support infrastructure and other support activities; provide material and non-material solution development; and provide support to operations and other support activities.

CBRN S&Es support many of the mission areas discussed above. Supporting the knowledge and technology generation and analysis function, CBRN S&Es work steadfastly within the Air Force Research Laboratory, Air Force Technical Applications Center (AFTAC), DOE/NNSA Laboratories (Los Alamos, Lawrence Livermore, Sandia, Oak Ridge, and Argonne), DTRA[12], and the Air Force Institute of Technology[13] to conduct research and development and develop new analytical techniques supporting the DOD counterproliferation mission.

Developing material and non-material solutions is also a key function of CBRN S&E personnel. Air Force CBRN S&Es actively support the development of advanced protective systems, such as at the 311 Human Systems Wing[14] and at DTRA. Additionally, CBRN S&Es are located at various system program offices. Lastly, engineers at the Air Armament Center Nuclear Weapons Directorate[15] provide engineering and analysis support to sustain USAF nuclear operations.

CBRN S&Es operate some of the Air Force's most advanced weapon systems. CBRN S&Es at the AFTAC[16] operate the United States Atomic Energy Detection System, which provides our national authorities with technical-information supporting the monitoring of the Limited Test Ban Treaty, Threshold Test Ban Treaty, and Peaceful Nuclear Explosion Treaty. Additionally, this organization provides technical support to the International Atomic Energy Agency. S&Es at the Nuclear Weapons and Counterproliferation Agency[17] provide direct linkages to operations by supporting the sustainment of the Air Force's portion of the US nuclear stockpile and by providing planning support to various air component commanders at the unified commands regarding the effects and consequences of offensive counter-CBRN targeting. Air Force CBRN S&E assigned with DTRA support the unified commands by supporting nuclear stockpile operations and providing expertise for potential WMD elimination and other counterproliferation activities. Finally, health physicists (medical S&Es) operate the Air Force Radiological Assessment Team[18] (AFRAT)—part of the Air Force Institute of Occupational Health. This group provides the JFC (through the senior Air Force medical commander) with complete and effective radioactive hazard detection and analysis supporting force protection and environmental decontamination efforts.

Lastly, from an infrastructure and institutional support perspective, CBRN S&Es provide expert advice to many of our senior leaders. These personnel are located throughout the DOD and interagency community. From the DOD perspective, CBRN S&Es provide expert advice to the Unified Combatant Commanders (e.g. United States Strategic Command) and Office of the Secretary of Defense (OSD) staff. Further, they represent DOD equities while assigned to the Central Intelligence Agency and the NNSA. The Air Force employs CBRN S&Es at the Air Staff in support of nuclear and counterproliferation operations (AF/XON) and intelligence support (AF/XOI).

Notes

[1] *The National Strategy to Combat Weapons of Destruction*, December 2002, Washington DC.

[2] Department of Defense Office of Force Transformation, *Military Transformation: A Strategic Approach*, available at http://www.oft.osd.mil.

[3] Office of the Secretary of Defense *Quadrennial Defense Review Report*, Washington DC: 30 Sep 2001, available at Hhttp://www.defenselink.mil/pubs/qdr2001.pdfH, p.iii-iv.

[4] Office of the Secretary of Defense, *Strategic Deterrence Joint Operating Concept*, February 2004, available at http://www.dtic.mil/jointvision/joc.htm.

[5] HQ USAF/XPXC, *The US Air Force Transformation Flight Plan*, November 2003, available at http://www.af.mil/library/posture/AF_TRANS_FLIGHT_PLAN-2003.pdf.

[6] Ibid, p. 2.

[7] Air Force Doctrine Document 1. *Air Force Basic Doctrine*, 17 November 2003, p. 73.

[8] Joint Publication-3-11. *Joint Doctrine for Operations in Nuclear, Biological, and Chemical (NBC) Environments*, 11 July 2000.

[9] Joint Publication 3-30. *Command and Control for Joint Air Operations*, 5 Jun 03, p. II-7.

[10] Air Force Doctrine Document 2-1.8. *Counter Nuclear, Biological, and Chemical Operations*, 16 August 2000.

[11] *Concept of Operations for Scientists and Engineers in the United States Air Force*, 2001, available at http://www.safaq.hq.af.mil/aqre/conops/CONOPS.pdf.

[12] Mission Briefing, *The Defense Threat Reduction Agency: reducing the threat of weapons of mass destruction*, Version 3.7, dated 8 Jan 04.

[13], Jodoin, Vince Lt Col, *Air Force Institute of Technology Graduate Nuclear Engineering Program*, Mission Briefing, Undated.

[14] Web Site, *HSW 311/YAC: CBRN Defense Systems Division*, available at https://hswya2.brooks.af.mil/common/mil-gov/ya/yac/yac.htm.

[15] More information on AAC/NWD can be found at http://www.nwd.kirtland.af.mil.

Notes

[16] United States Air Force, *Air Force Mission Directive 49: Air Force Technical Applications Center*, 25 February 2003.

[17] United States Air Force, *Air Force Mission Directive 58: Air Force Nuclear Weapons and Counterproliferation Agency (AFNWCA)*, 13 November 2002.

[18] Air Force Institute of Occupational Health, *Air Force Radiological Assessment Team (AFRAT)*, http://starview.brooks.af.mil/afioh/Environmental%20Programs/sdrh_afrat.html.

Chapter 3

CBRN S&E Development

We must continue to break down the functional stovepipes and tribal loyalties that stand in the way of translating our vision into decisive operational capability. We must get out of the mode of thinking only in terms of platform rather than in terms of capabilities[1].

— General John P. Jumper, USAF Chief of Staff

The Air Force is unique in that approximately 20 percent of its laboratory S&E government workforce is active duty military. It is from this cadre that we draw technical competence needed in our military Service leadership to operate an ever more technical force. In addition, this gives us a direct link to the warfighter, which in turn helps us to focus technology development on warfighting capability needs[2].

— Mr. James B. Engle,
Deputy Assistant Secretary (Science, Technology, and Engineering)

From the previous section, we see the compelling need for CBRN S&Es to provide technical solutions to the warfighter, and in many cases provide the operational expertise for certain capabilities. In this section, I discuss developmental issues for CBRN personnel and recommend a path forward to solve key issues with this workforce. Specifically, I will discuss the unique education and training requirements for CBRN S&Es. Following this, I will discuss workforce development issues for this group and explore possible solutions.

Work Force Demographics—The Problem

As discussed previously, the USAF has historically maintained a cadre of nuclear science and technology experts to support our treaty monitoring and nuclear deterrence missions. Additionally, we have developed a much smaller cadre of S&Es expert in chemical and biological weapon effects, with most of this expertise residing in the civil engineering and medical community. Radiological weapons expertise is resident in the USAF Health Physicist community.

During the decade following the end of the Cold War, USAF nuclear science and technology expertise began to shrink as many programs previously requiring such expertise were cut or their nuclear requirement reduced. Unfortunately, the cuts went too far.[3] The USAF cadre of nuclear experts was never large. The Air Force Institute of Technology (AFIT) Graduate Nuclear Engineering (GNE) Program has historically been the "training program" for Air Force and Army nuclear S&Es.[4] This program had requirements in the 1980s of approximately 14 to 16 officers per year.[5] In the mid-1990s, the program was scaled back drastically, producing only 2-4 nuclear S&Es per year. Interestingly, while USAF maintains a significant fraction of US nuclear weapons and the DOD nuclear treaty-monitoring mission, the United States Army has actually provided more students to the GNE program on an annual basis than the USAF (between 4 and 7 officers per year).

In addition to the problem of identifying and educating military CBRN personnel, we face significant challenges in developing and retaining our civilian workforce. Roughly half of the AF CBRN S&E workforce is civilian (approximately 222 personnel).[6] Given that approximately fifty-percent of Air Force S&E civilians will be eligible to retire within the next 5-years, we can only assume many of our most experienced CBRN experts will be among this group.[7] Thus, it is

critical that recruiting, educating, and training civilian CBRN S&E personnel be accorded same level of attention as that of our military members.

Thus, the author asserts that significant human capital development challenges exist for CBRN S&E personnel. First, we have strong and unique requirements for CBRN S&E personnel throughout our enterprise to support USAF and DOD operations. Secondly, the USAF is competing with other departments for this limited expertise—particularly the US Army, US Navy, Homeland Security, and NNSA. Finally, the author asserts that we must better utilize our CBRN S&E officers and civilians to capitalize on the strengths of each of these groups to successfully meet the CBRN challenges of the future. The rest of this section will discuss these issues in the context presented above.

Education and Training of CBRN S&E Personnel

Few avenues exist for providing our S&E personnel with militarily unique CBRN education and training. Three primary venues exist to educate our CBRN S&Es: the Air Force Institute of Technology, the Defense Nuclear Weapons School, and the Air Force National Laboratories Technical Fellowship Program. This section will discuss each of these in turn.

The Air Force Institute of Technology (AFIT) Graduate Nuclear Engineering (GNE) Program[8]

The AFIT GNE program has been educating USAF and DOD nuclear S&E personnel since the 1950s. It is located at Wright-Patterson AFB, OH. The AFIT GNE program is open to all qualified DOD personnel. The program provides graduate education in theoretical physics, nuclear applications (radiation detection, health physics, etc), and the physics of nuclear explosives and their effects. In last several years, the United States Army has actually provided more students to the program than the Air Force. The GNE program consists of two

components: a graduate Masters program and a Doctoral program. The graduate Masters program is an 18-month program. The Doctoral program is a 36-month program and grants a Doctoral of Philosophy degree.

Defense Nuclear Weapons School (DNWS)[9]

The DNWS, operated by DTRA, is located at Kirtland AFB NM. The mission of the DNWS is to provide the warfighter with information relating to nuclear weapons, other WMD , and their effects. The DNWS curriculum also links operations to the technical community by training personnel in consequence management response to CBRN incidents. The DNWS conducts multiple courses on various topics throughout the year. Course of particular interest to CBRN S&Es are the *Commander and Staff Radiological Accident Response (CASRAR) Course; Civil Support Team Radiological Training Course (CST-RTC); Hazard Prediction and Assessment Capability (HPAC); the Nuclear Weapons Orientation Course (NWOC); the Nuclear Research and Operations Officer Course; Proliferation, Terrorism, and Response Course; and the Medical Effects of Ionizing Radiation (MEIR) Course.*

Although not a technical or graduate school, DNWS provides critical context and in-depth procedural understanding to its students. Further, the DNWS is also the nexus in which operational, intelligence, and S&E community naturally come together and receive standard training.

Air Force National Laboratories Technical Fellowship Program (AF-NLTFP)[10]

The AF-NLTFP was originally developed in concert between AF/XON and Sandia National Laboratory to increase technical knowledge of nuclear weapons among selected Air Force officers. The program has expanded to include Sandia National Laboratory, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, Argonne National Laboratory,

and Oak Ridge National Laboratory. Further, in 2003, the program became part of the Air Force's Intermediate and Senior Developmental Education portfolio. Thus, the program will be educating some of the Air Force's best and most qualified officers and civilians in the technical details of CBRN weapons. Further, it will help to redevelop relationships among Air Force operators and our brightest scientists and engineers in the NNSA laboratories.

Other Potential Areas of Collaboration

In addition to the programs identified above, unexplored potential exists in other elements of the United States Government and DOD. For example, the United States Army Chemical School conducts their *Joint Senior Leaders' Course*[11], focusing on high-level issues associated with the CBRN threat. The Central Intelligence Agency, in conjunction with the NNSA, provides several courses to intelligence community analysts regarding the technical aspects WMD. Further, the Centers for Disease Control and the United States Army Medical Research Institute of Infectious Disease (USAMRIID) provides resident courses to DOD medical personnel: *Medical Management of Chemical and Biological Casualties Course* and the *Field Identification of Biological Warfare Agents.*[12]. Although focused on the medical aspects of CB agents, attendance at these courses by an appropriately educated CB S&E would help our CB personnel understand the challenges of the medical operator and their S&T needs.

Developing the CBRN S&E

One of the Air Force's core competencies is "developing airmen." As discussed previously, CBRN S&E's provide critical capabilities to the warfighter: from providing capabilities for force protection to monitoring some our most important treaties. Key to sustaining this force is to determine the right development approach that ensures our people have the right skills, at the

right place, and at the right time. Force development seeks to do this.[13] This section will discuss how CBRN military and civilian personnel are managed in the Air Force and discuss three possible strategies that might help better integrate them into Air Force operations while maximizing the utility of this group and their skills.

The Military CBRN S&E

Air Force CBRN S&Es generally fall in to one of two Air Force Specialty Codes (AFSCs): 61S (scientist) or 62E (developmental engineering). Among the 61S AFSC, officers are generally physicists/nuclear engineers (61S3D) or chemists/biologists (61S3C). Amongst the 62E family, CBRN engineers tend to be coded as 62E3G (general project engineers).[14] The role of the "blue suit" S&E is to provide a conduit to the operational Air Force for S&T. Generally, these officers spend their first ten years acquiring more education (usually at AFIT or at a civilian institution) and working as project officers in a variety of system program offices, laboratories, and field operating agencies (such as AFTAC).[15] Some officers seek to obtain operational experience in one of many eligible operational AFSCs during this time. From 10 to 15 years of service, they transition to mid-level managers and many move into the acquisition field (63A AFSC).

The Civilian CBRN S&E

The civilian S&E follows a similar path as the military S&E. Instead of an AFSC, civilians are coded under one of many occupational specialty codes, ranging from physics to bioenvironmental engineering. Civilian S&Es provide in-depth expertise and corporate memory for many of our organizations, complementing the role of the military S&E.[16] Civilian personnel tend to stay in one job much longer than their military counterparts, allowing them to develop in-

depth expertise and long-term relationships with defense contractors that are generally not possible for military S&Es.

Possible Solutions

The Air Force S&E community has always placed a premium on technical expertise development, but has tended to underemphasize operational and leadership development. This is changing somewhat as the USAF institutionalizes its development team construct.[17] However, CBRN S&Es have needs that must be accounted for in their development if the Air Force is going to successfully carry out our counter-WMD missions. For example, the majority of CBRN S&Es have no operational experience and are in fact directed into the acquisition career field[18]. This is troublesome given that most of the CBRN challenges the USAF and DOD will experience require operationally-useful technological solutions.

One course of action (COA) involves institutionalizing operational experience among military CBRN S&Es. Currently, some S&Es receive developmental training in another AFSC for 2-3 years.[19] I advocate that a program be developed whereby all military CBRN S&Es are explicitly managed to receive education and training in one of many "associate" operational AFSCs where CBRN knowledge is critical: civil engineering readiness (32E), bioenvironmental engineering (43E), health physics (43Y), munitions maintenance (21M), or space and missile operations (13S). This program would require strong advocacy by both the S&E Functional Manager (SAF/AQR) and the CBRN S&E Functional Manager (AF/XON) to ensure that these operationally-experienced S&Es return to the CBRN community following their developmental assignment.

Another COA involves creating an operationally-focused S&E career field family (notionally 17Txx[20]). The Air Force and DOD are developing concepts such as effects-based

operations and becoming more capabilities-centric. From a personnel perspective, operational and some support officers generally are categorized by either the platform or function they provide, e.g., F-15 pilot (11F4F) and munitions maintenance (21Mxx). S&Es, on the other hand, are categorized by their discipline, e.g., physicist (61S3D), developmental engineer (62E3G). Neither classification is effects-based. However, the operational career fields are more effects-aligned than the S&E career fields.

Because the S&E career fields must be more operational aligned, I advocate the creation of a new career field, notionally called "Technical-Operations." This career field (17Txx) would be aligned under the non-rated operations community and would initially develop and train S&Es in the following areas: military-effects analyst (17TxA), advanced weapons-technology operations (17TxD), counter-CBRN technical operations (17TxN), and space technology operations (17TxS). The military effects analyst, notionally composed of operations research analysts and other S&Es expert in modeling and simulation, would provide our air operations centers (AOC) and staffs with an officer expert in the technical aspects of effects assessments grounded in operations. The advanced weapons-technology operations officer would provide the warfighter with expert operators for advanced weapons, particularly directed-energy weapons, being developed by the Air Force. The counter-CBRN technical operations officer would provide the warfighter with operationally-relevant counter-CBRN solutions ranging from intelligence support to force protection activities (such as providing expert operation of advanced detection technologies). Finally, the space technology operations officer would provide our space and missile operators a conduit for operationally-focused space technology solutions and effects-based assessments for our space assets and would be extremely useful in supporting counter-space and force application mission areas.

The entry requirements for the 17Txx career field would be very similar to the 61S/62E career-fields. The advanced technical degree, in addition to technical training, would still be the "entry requirement" for attaining expertise in the field. However, these officers would primarily serve in operational units at the company grade level (first 10 years) and then begin to transition to leadership positions in the S&T community to provide a solid conduit between the operational and acquisition communities, breaking down the functional barriers which seem to prevent cross-pollination between the customer (operators) and the development (S&T) communities. Further, putting 17Txx officer out in the field allows the Air Force to rapidly experiment with new technologies as they become available by providing well-educated and well-trained S&Es to field new systems and techniques. Further, leadership opportunities would be available to S&Es as new flight and squadron command positions are created.

The final course of action involves adopting the United States Army Functional Area 52 career path model.[21] The US Army has "functional areas" or FA, which are staffed with focused experts to support their missions. One of these functional areas, the FA-52, is dedicated to nuclear research and operations. The Army staffs the FA-52 career field solely with S&E officers who have served in operational positions for roughly 8 to 10 years. Following their operational tours, these officers are sent to one of many graduate schools to obtain a technical degree (usually in physics or nuclear engineering). They then spend the rest of their careers in the FA-52 career field. Because of the uniqueness of the FA career fields, these officers compete for promotion only among themselves and not through the total force. By allowing for promotion competition and opportunity only among FA-52 personnel, the Army creates incentives for the development of expertise. The FA-52 model would translate into the Air Force

personnel system as one of our competitive career fields, such as the Biomedical Service Corps or Judge Advocate General's Corps.

Notes

[1] Jumper, John P. General *Technology-to-Warfighting: Delivering Advantages to Airmen,* Chief's Site Picture, 17 Jul 03, available at http://www.af.mil/media/viewpoints.

[2] Engle, James B. Fi*scal Year 2005 Air Force Science and Technology,* Presentation to the Senate Armed Services Committee Subcommittee on Emerging Threats and Capabilities, March 2004, available at Hhttp://armedH-services .senate.gov/statement/2004/March/Engle.pdf

[3] AF/XON, Major General Robert Smolen, testified to the Senate Armed Services Committee, Strategic Subcommittee regarding the declining nuclear S&E expertise in the Air Force. His statement found at http://armed-services.senate.gov/statemnt/2003/April/Smolen.pdf.

[4] The author found no reference to graduate science and engineering programs focused on biological and chemical weapons effects similar to the AFIT GNE program. The AFIT program addresses all aspects of military relevance with respect to radiological weapons.

[5] Jodoin, Vince Lt Col *Air Force Institute of Technology Graduate Nuclear Engineering Program,* undated, slides 12, 15, 16-17.

[6] Compiled by author from the AF/XON & SAF/AQR CBRN S&E Workforce Study, 24 Jan 2003.

[7] Air Force Materiel Command, *AFMC Work Force Shaping*, United States Air Force, available at http://www.afmc.wpafb.af.mil/HQ-AFMC/PA/library/WFS_Fact_Sheet.htm

[8] Jodoin, Vince Lt Col *Air Force Institute of Technology Graduate Nuclear Engineering Program,* undated.

[9] *Defense Nuclear Weapon School Courses,* available at https://dnws.ao.dtra.mil/Body/CourseDescription

[10] Torok, Mark. Talking Paper on New Air Force National Laboratory Technical Program (AF-NLTFP), AF/XONO, 15 Sep 03.

[11] United States Army Chemical School Web Site, http://www.wood.army.mil/usacmls.

[12] United States Army Medical Research Institute of Infectious Disease web site, http://www.usamriid.army.mil/education

[13] The Air Force Chief of Staff, General John Jumper, is a strong proponent of force development. The program is discussed at http://www.af.mil/media/viewpoints/Total_Force_Development.pdf

[14] Air Force Manual 36-2105, *Officer Classification,* 31 Oct 03, p. 242 & 244

[15] SAF/AQRE, *Career Development Guide for Scientists and Engineers*, available at http://www.safaq.hq.af.mil/aqre/mentoring/docs/3Jun_CDGt.pdf.

[16] Ibid

[17] The Air Force Chief of Staff, General John Jumper, is a strong proponent of force development. The program is discussed at http://www.af.mil/media/viewpoints/Total_Force_Development.pdf

[18] SAF/AQRE, *Career Development Guide for Scientists and Engineers*, available at http://www.safaq.hq.af.mil/aqre/mentoring/docs/3Jun_CDGt.pdf.

Notes

[19] The Air Force Personnel Center manages several acquisition-to-operations programs such as Acquisition & Logistics Experience Exchange Tour (ALEET) and the Space Operations & Acquisition Exchange Program (SAEP).

[20] 17Txx is the next available classification in the non-rated operations family

[21] More information on the FA-52 Career Field is located at https://www.perscomonline.army.mil/opfamis/52/fa52.htm.

Chapter 4

Conclusions and Recommendations

> *The Air Force requires highly developed Scientists and Engineers to meet the 21st century challenges of overwhelming technological leadership and the ability to respond quickly to the demands of our rapidly changing world.*[1]
>
> — Dr. James G. Roche, Secretary of the Air Force &
> General John P. Jumper, USAF Chief of Staff

The need for CBRN S&Es is perhaps greater now than in any time in our past. National direction, Joint doctrine, and Air Force doctrine clearly allow for strong operationally-focused technologists to counter the WMD threat. However, S&T focused doctrine should be developed to further educate the warfighter in how the capabilities he requires are developed and presented to the joint force. In order to ensure the DOD has the expertise and capabilities it needs to combat WMD, new personnel employment approaches are needed. Training, education, and leadership development are essential if the DOD is to apply transformation to combating WMD. The Air Force should consider changes to how military CBRN S&Es are developed in order to maximize the support this group provides to the warfighter.

Recommendations

It is clear from my research that significant strategic and operational support exists for the continuation and enhancement of the CBRN S&E corps. However, it is noteworthy that while S&T solutions are the norm for DOD and Air Force counter-CBRN operations, there is little to

no doctrine explicitly discussing how to best provide S&T solutions to the warfighter. At the implementation level, much guidance exists with regard to acquisition processes, but there does not seem to be a compendium of best practices for how S&Es can contribute to warfighting missions nor the capabilities of various disciplines within the Air Force S&E community.

Thus, my first recommendation is that doctrine specific to technology development and the warfighter be developed, with a specific annex for CBRN technology. Such doctrine, drafted in close coordination with SAF/AQ, Air Force Materiel Command, and AF/XO would serve to better educate the warfighter and acquisition communities on the unique capabilities of S&Es in support of Air Force missions and bolster the Air Force core competencies of "technology-to-warfighting" and "integrating operations."

My second recommendation is for the USAF to examine the creation of the 17Txx career field. The S&E Functional Manager (SAF/AQR), in concert with the CBRN S&E Functional Manager (AF/XON) and Air Force Personnel (AF/DPM and DPL), should explore options related to creating the 17Txx career field. Clearly, numerous details need to be identified and resolved, such as education and training requirements, accession rates, and creation of an appropriate implementation structure. However, the creation of this career field with a commensurate realignment of military S&E billets in the 61S/62E community will place expert technology advocacy in the operational community as well as develop seasoned leaders for the CBRN S&T community with strong operational ties.

Notes

[1] SAF/AQR, *Career Development Guide for Scientists and Engineers*, United States Air Force, May 2003, available at http://www.safaq.hq.af.mil/aqre/mentoring/docs/3Jun_CDGt.pdf.

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